Discharge Monitoring Report (DMR)

Instruction Manual for Municipal Sewage Treatment Plant Operators

October 1999
Publication # 95-78 (revised)

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Prepared by
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WASTEWATER TREATMENT PLANT MONITORING REPORT

NPDES PERMIT NO. WA0025558 MONTH FEB , 19 95

FACILITY NAME OLSONVILLE COUNTY SALMON

RECEIVING WATER MELLOW CREEK PLANT OPERATOR BOB ROANOKE

PLANT TYPE AERATION BASIN POPULATION SERVED about 4,000

	INFLUENT				EFFLUENT											DIGESTER		
MP-ID	IN1	IN1	IN1	IN1	1	1	1	1	1	1	1	1	1	1	1	P	P	P
DATE	BOD5 mg/L	BOD5 LBS/DAY	TSS mg/L	TSS LBS/DAY	FLOW MGD	BOD5 mg/L	BOD5 % REMOVAL	BOD5 LBS/DAY	TSS mg/L	TSS % REMOVAL	TSS LBS/DAY	CHLORINE, TOTAL RESIDUAL mg/L	CHLORINE, TOTAL RESIDUAL LBS/DAY	FECAL COLIFORMS CFU/100 ML	pH STANDARD UNITS	DO mg/L	TEMPERATURE CENTIGRADE	pH STANDARD UNITS
1					0.52							0.3	1.3		7.0	5.8	12.5	7.1
2					0.43							0.3	1.1		7.2	5.9	12.5	7.2
3					0.48							0.4	1.6		7.2	5.2	12.5	7.2
4																		
5																		
6	200	550	310	853	0.33	19		52	34		94	0.3	0.8	75	7.3	6.6	12.9	7.3
7					0.28							0.4	0.9		7.4	5.6	12.9	7.2
8					0.25							0.5	1.0		7.5	5.8	12.7	7.2
9					0.32							0.4	1.1		7.2	6.4	12.7	7.2
10					0.40							0.3	1.0		7.5	4.0	12.7	7.3
11																		
12																		
13	201	788	300	1176	0.47	6		24	3		12	0.5	2.0	E10000	7.5	5.5	12.3	7.3
14					0.35							0.4	1.0	90	7.5	4.0	12.1	7.3
15					0.28							0.3	0.7	75	7.3	6.8	11.8	7.3
16					0.42							0.3	1.1	80	7.3	5.6	11.9	7.5
17					0.38							0.4	1.3		7.5	5.2	12.3	7.4
18																		
19																		
20	195	976	305	1526	0.60	11		55	15		75	0.3	1.5	100	7.2	5.1	12.9	7.4
21					0.50							0.2	0.8		7.2	6.1	13.1	7.1
22					0.42							0.4	1.4		7.3	6.4	13.1	7.3
23					0.48							0.5	2.0		7.2	5.4	13.1	7.1
24					0.40							0.3	1.0		7.8	6.0	13.0	7.1
25																		
26																		
27	180	781	280	1258	0.52	7		30	6		26	0.5	2.2	45	7.8	6.0	13.0	7.2
28	205	684			0.40	10		33				0.4	1.3		7.5	5.6	13.1	7.2
29					0.36							0.3	0.9		7.2	6.8	13.1	7.1
30					0.35							0.4	1.2		7.2	5.5	13.0	7.2
31					0.38							0.4	1.3		7.2	5.8	12.9	7.3
	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	GEM	MIN	AVG	AVG	MIN
	196	756	301	1203	0.41	11	94	39	15	96	52	0.37	1.2	151	7.2	5.7	12.7	7.1
PERMIT		1300		1300	1.20	30	85	250	30	85	250			200	6			
	MAX	MAX	MAX	MAX	MAX	AVW		AVW	AVW		AVW	MAX	MAX	GM7	MAX	MAX	MAX	MAX
	205	976	310	1526	0.52	19		55	34		94	0.5	2.17	271	7.8	6.8	13.1	7.5
LIMITS						45		375	45		375			400	8			

MAX = MAXIMUM MIN = MINIMUM AVG = AVERAGE MONTHLY AVW = MAXIMUM AVERAGE WEEKLY

GEM = MONTHLY GEOMETRIC MEAN GM7 = MAXIMUM WEEKLY GEOMETRIC MEAN

REMARKS: HIGH FECAL COUNT ON 2/13 DUE TO CHLORINATOR FAILURE, NEW PARTS ON ORDER

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. (Code of Federal Regulations Title 40, Section 122.22D, (Per authority of RCW 90.48.260).

NAME AND TITLE ..... SIGNATURE .....

Figure 1. Sample Ecology Discharge Monitoring

Introduction

This instruction manual was prepared to help wastewater treatment plant operators fill out their Department of Ecology (Ecology) Discharge Monitoring Reports (DMRs). Many permittees also fill out a U.S. Environmental Protection Agency (EPA) DMR. This manual is also useful for completing the EPA form.

The new Ecology DMRs issued in late 1994 are "preprinted." This means that they have been developed specifically for your facility. The forms can be broken into three sections: The **General Facility Information Section**, the **Daily Reporting Section**, and the **Monthly Summary and Remarks Section** (Figure 2). Figure 1 shows a typical DMR for a small municipal treatment plant.

The primary purpose of the DMR is to determine whether your facility is in compliance with the requirements of its wastewater discharge permit. Noncompliance determined from the DMR can result in enforcement actions by Ecology or citizen's suits by nongovernmental parties. Thus, it is important to fill out the DMR properly. Besides its use in determining compliance, the DMR indicates how well a plant is operating and provides information on plant performance for a variety of interests. DMR data can show trends in area growth, collection system quality, and changes in the nature of influent for city planners and engineers. It can also help justify plant expenditures and protect your city from claims that it has endangered the environment. Influent characteristics are especially important if there are industrial discharges to your plant.

If you develop questions while you read the manual or after you have finished reviewing it, please call your Ecology Regional Office to get more information. You can also call your regional technical assistance officer. The phone numbers for your regional office and technical assistance officer are provided on page 20 of this manual.

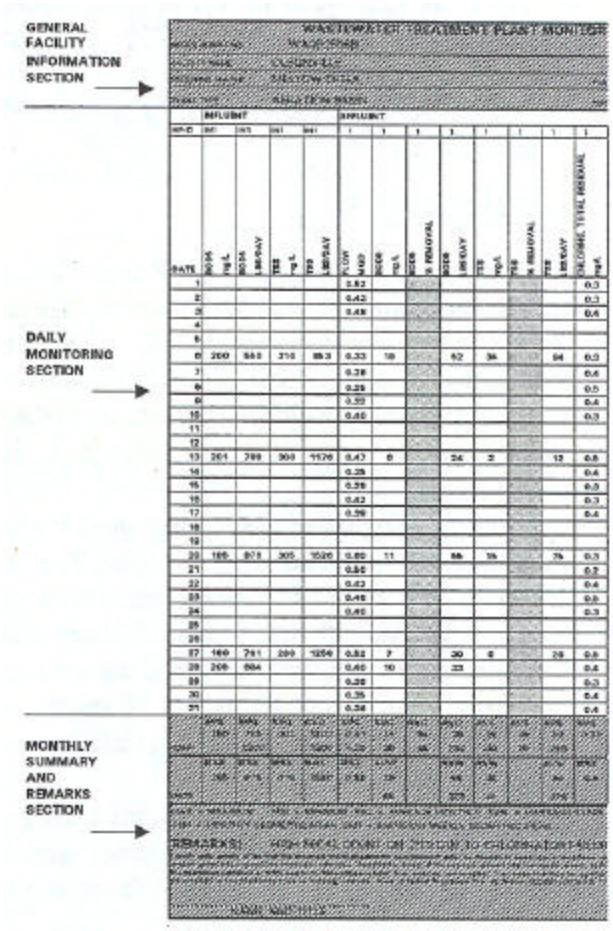


Figure 2. The three major sections of the DMR

General Instructions

Your facility's wastewater discharge permit contains effluent limits, required testing, and other reporting requirements for your facility. A copy of the permit must be available at the plant for you to consult when necessary. You should compare the limits in the permit to the ones on your preprinted DMR. Review the following subsection "Permit Limits" before doing this. Contact your Ecology regional office if the limits do not appear to be correct. Remember the following important points when preparing the DMR:

- The DMR must be signed in ink by a principal executive officer or ranking elected official. Operators may sign the DMR if the responsible authority has sent a letter to Ecology stating that signature authority has been granted to the operator.

- All data should be typed, written in ink, or computer printed.

- All excursions from permit limits must be circled in red. An explanation of the cause or possible causes of the excursions and the corrective action you are taking should be included in the REMARKS section of the DMR or on a separate page.

- The DMR must be in the mail to the appropriate Ecology regional office by the date specified in your discharge permit (generally the 15th of the month following the end of the reporting period).

- The DMR must have an original signature. Photocopies are acceptable if the copies submitted are signed in ink.

Permit Limits

When you receive a new set of DMR forms from Ecology, you should check to see if the preprinted limits are correct or are absent. Your facility's permit contains both Special Conditions and General Conditions. The Special Conditions (S.1, S.2, etc…) are unique to your facility whereas the General Conditions (G.1, G.2, etc…) are the same in all permits. Look in sections S.1 and S.4 to compare the limits on the DMR form with those in your facility's latest permit. You may also have additional requirements in an administrative order that could be reflected on your DMR.

Your facility's preprinted DMRs may have limits under the flow, influent BOD_5 (5-day biochemical oxygen demand), and influent TSS (total suspended solids) loading columns. These values are usually 85 percent of the design limits for your facility. Some Ecology regional offices add these 85 percent design limits to help them track when plants are nearing capacity. Excursions over these limits are not violations, but they may signal the need for your facility to take additional action (see section S.4 or your permit for more information). It should be noted that excursions over the 100 percent design limits for a facility may be considered violations because they may indicate that a plant is overloaded.

If you have questions about the preprinted limits on your DMR or if you do additional tests required by your Operations and Maintenance (O&M) Manual that you would like to record on your DMR, call or write your regional Ecology office. We can add additional columns on the DMR if you wish.

Representative Sampling

Ecology established the testing requirements in your facility's permit under the assumption that the plant is always running normally. Thus, testing for BOD_5 or TSS two or three times a week is considered representative of the four or five days testing was not performed. If your plant experiences circumstances that are out of the ordinary, such as high flows due to winter inflow and infiltration, or slug loads, you should attempt to sample your plant's wastewater during these events to document and characterize their effect on your plant. Similarly, if you have changed the normal process control strategy (for example: you needed to shut down secondary treatment to prevent a solids washout, or there was a major equipment breakdown) then that event should be characterized by additional sampling.

How to Define Time Periods

Monthly discharge reports should report all data for a calendar month. A calendar month begins on the first day of the month and ends on the last. You should compute your weekly limit values using data starting on Sunday and ending on Saturday. Do not use rolling averages to report *Maximum Weekly Averages*. Because weeks do not fit neatly into each month, you will usually be using data from surrounding months when computing your *Maximum Weekly Averages*. You do not need to re-record the data from these other months. When computing a *Weekly Average* for a week that overlaps two months, follow the rule below:

- The month in which the largest number of days of a week falls into is the month in which you record the weekly average. For example, if four or more days of an overlapping week fall into the month of February, then the *Maximum Weekly Value* for that week occurred in February. Use this rule for *Maximum Weekly* BOD_5, TSS, and Fecal Coliform Bacteria values.

When reporting 24-hour composite data for BOD_5, TSS, or other parameters, record the final test value on the day contributing the most to the sample (usually the day it was started). Make sure that flow data is reported in the same way.

Data That Should Not Be Reported

Do not use data from invalid tests or improperly functioning equipment. If you encounter problems with a BOD test, such as insufficient depletion of oxygen, then you should not use this data to determine compliance with permit limits. Similarly, if you know that your flow meter or other instrumentation is not working properly, you should not report that data as well. Because the failure to perform a required test is a permit violation, you should indicate in the REMARKS area why a test was not performed and what steps have been taken to resolve the problem.

Reporting Data from Additional Tests

You must use all data collected using approved methods when calculating the *maximum weekly* and *monthly average values*. Thus if you do more BOD_5, TSS, or fecal coliform tests than are required by the permit, you must report the results and use them in your monthly calculations. If you are submitting additional testing data from Special Condition S.2. that is not listed on your monthly preprinted DMR (such as annual/quarterly metals or priority pollutant scans) then you should write a note in the REMARKS section or on a separate sheet of paper to ensure the submission is noted and the data is recorded properly at your regional office.

Failure to Submit a DMR and Accurate Reporting

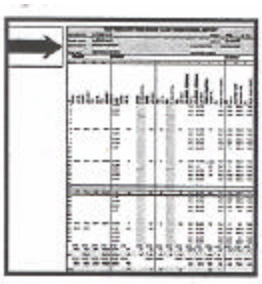
Failure to submit a DMR is a permit violation. Operators should be aware that they are responsible for recording accurate data. Although the ultimate responsibility for violations at a facility belongs to the responsible official, falsification of data on DMRs is cause for revocation of an operator's certificate.

Blank Columns

Use any blank columns on your DMR to report other monitoring data that is not specifically required by your permit or any other data, such as settleable solids, dissolved oxygen, SVI, or solids inventory.

General Facility Information Section

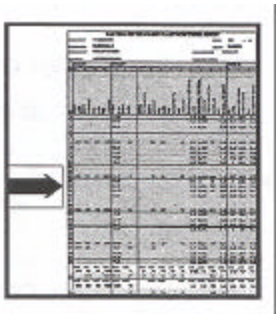
At the beginning of a monitoring period, complete the **General Facility Information Section** at the top of the DMR. If you are using preprinted forms supplied by Ecology, much of this information may already be filled in (as in Figure 1). The order of the parameters (types of tests to be performed) that appear on your facility's form may vary from the one in Figure 1. Table 1 lists the instructions for this section.



ITEM	INSTRUCTIONS
Permit Number	Enter permit number found on the cover page your facility's permit
Month, Year	Enter monitoring month and year
Facility Name	Enter facility name as it appears on the cover page of the permit
County	Enter the county the facility is in
Receiving Water	Use receiving water listed on the cover of the permit (not applicable to land discharges)
Plant Operator(s)	Name of principal operator or superintendent in charge. Additional or changes in operators should be listed in the REMARKS section
Plant Type	Enter type of plant: Trickling filter, activated sludge, extended aeration, lagoon, etc.
Certification Grade	List certification grade of the principal operator and/or superintendent in charge
Population Served	Enter the population your collection system serves. If you have industrial contributors, enter the total number of Equivalent Residential Units if it is known.

Table 1. Basic Elements of the General Information Section of the DMR

Daily Reporting Section



The bulk of your DMR entries are made in the **Daily Reporting Section**, which is comprised of various subsections: Influent, Process, and Effluent. There may be several Process subsections--each will have the name of a treatment unit such as digester, pond #1, or aeration basin. The parameters on the DMR reflect the testing required under Special Condition S.2. of your facility's permit and may include those found in your facility's O&M manual. If your DMR does not contain a column for a test you would like to record, call Ecology so that a new form can be made and sent to you. The frequency of testing required by the permit and O&M manual are the minimum levels that must be performed.

If there is insufficient room for entering additional data for one day, use any blank columns on the form or additional sheets of paper. All pages should be present when the DMR is signed by the authorized representative. Perform calculations on additional sheets of paper but do not submit those sheets unless you have questions concerning how a discharge value should be calculated. Tables 2 and 3 contain instructions for recording specific parameters on the DMR. Fecal coliform test values should be calculated using the guidance in Appendix A of this manual. These instructions supersede the counting instructions in both Standard Methods and previous Ecology publications.

PARAMETER	VALUE TYPE[a]	INSTRUCTIONS
Influent		
Flow, MGD or GPD	Monthly Average[b], Daily Value	Use daily averages for recording daily flow, not daily peak flow. Be sure that flow values and BOD_5/TSS values correspond to the same time period so influent loading calculations will be representative. See text for monthly average flow calculation (formula # 2).
pH	Maximum, Minimum	Report pH to tenths of a standard unit.
5-day Biochemical Oxygen Demand (BOD_5), mg/Lmg/L	Monthly Average, Daily Value	If a BOD_5 test result is invalid, explain why in the REMARKS section or on an extra sheet of paper. Take a 24-hr composite sample unless specified otherwise in the permit. Make sure flow data corresponds with the time period BOD_5 samples were taken.
Total Suspended Solids (TSS), mg/Lmg/L	Monthly Average, Daily Value	See notes for BOD_5 above.
Dissolved Oxygen (DO), mg/Lmg/L	Monthly Average, Daily Minimum	Use DO probe and meter or titration. Report to tenths of a mg/Lmg/L
Temperature	Monthly Average, Minimum, Maximum	Report in either Fahrenheit or Centigrade degrees, but be consistent. Request a change in the unit used on the preprinted DMR if necessary.
Ammonia (NH_3-N)	Monthly Average & Daily Value *or* Single sample value	If ammonia testing is required only once per year and there is no column on your DMR, then record ammonia test data in the REMARKS section and write a comment indicating it is your annual test value. If there is a column provided and only one test is done per month, summarize value in the MAX, MXD, or SIN block at the bottom of your DMR. If you have a monthly or weekly testing requirement and there is no column, request a new preprinted form. Record in specific unit used in permit or form. Otherwise use mg/L.
Metals	Monthly Average & Daily Value *or* Single sample value	See comments for ammonia testing above. If you have questions about reporting metals data (or other *toxics* with very low detection levels), then refer to the subsection "Reporting Data on Toxic Chemicals...," later in this manual. Contact your Ecology regional office or technical assistance officer for additional help.
BOD_5 Loading, lbs/day	Monthly Average, Daily Value	When required, influent loading is calculated each day an influent BOD_5 test is done. Average these daily loading values to get the monthly average. Make sure flow values reported on the DMR correspond with the BOD_5 samples taken over the same time period. Always use influent flow values for this calculation unless your facility has only an effluent flowmeter. Use formulas 3 & 4.
TSS Loading, lbs/day	Monthly Average, Daily Value	See notes on BOD_5 loading above.
Process		
Note[c]	Average, Max., Min.	

Footnotes

[a] *The following abbreviations are used in many preprinted DMR forms: AVG = Monthly Average, AVW = Maximum Weekly Average Concentration, GEM = Monthly Geometric Mean, GM7 = Maximum Weekly Geometric Mean, MXD or MAX = Maximum Daily Value, MIN = Minimum Daily Value, SIN = Single Sample*

[b] *Use Arithmetic Mean for calculating all influent Average Values.*

[c] *Process parameters vary with the type of treatment system. Because there are many possible combinations, individual parameters are not addressed here. Contact your Ecology regional office if you have any questions on how to record process control data.*

Table 2. General Instructions For Reporting Influent And Process Control Data on the DMR - All samples must be representative of raw influent and should not be contaminated by return flows. NOTE: Some regional offices do not require influent loading data to be recorded

PARAMETER	VALUE TYPE[a]	INSTRUCTIONS
Effluent		
Flow, MGD or GPD	Monthly Average[b], Daily Value	Use daily averages for recording daily flow, not daily peak flow. Be sure that flow values and BOD_5/TSS values correspond to same time period when recording data and performing influent loading calculations. Use Formula #2[c].
pH	Minimum, Maximum	Report pH to tenths of a standard unit
5-day Biochemical Oxygen Demand (BOD_5), mg/L	Monthly Average, Max Weekly Average, Percent Removal	If a BOD_5 test result is invalid, include an explanation in the REMARKS section or on an extra sheet of paper. Take a 24-hr composite sample unless specified otherwise in the permit. Make sure flow data corresponds with the time period BOD_5 samples were taken. Chlorinated samples must be dechlorinated/reseeded. Percent removals are calculated using average monthly influent and effluent values.
Total Suspended Solids (TSS), mg/L	Monthly Average, Max Weekly Average	See BOD_5 notes above. No need to dechlorinate and reseed TSS samples!
Settleable Solids	Monthly Avg, Daily Max	Report in ml/l, record trace values as < 0.1 ml/l. Should be a grab sample.
Temperature	Monthly Average, Daily Max. and Min.	Report in either Fahrenheit or Centigrade degrees, but be consistent. Request a change on the preprinted DMR form if necessary.
Chlorine, Residual, mg/L	Monthly Average, Daily Value	Chlorine *must* be reported as Total Residual Chlorine. Total Residual Chlorine = (Total Free Chlorine) + (Total Combined Chlorine). If you take several chlorine measurements on one day, you must report all of these values and the time of sampling. Use a separate sheet of paper if needed. Always test chlorine level when sampling for fecal coliforms. If more than one chlorine test is taken on one day, you must average the individual values to get the daily value. Use formula #1.
Chlorine, residual, lbs/day	Monthly Average, Daily Loading Value	Use formulas #3 & 4.
Ammonia (NH_3-N), mg/L	Monthly Average & Daily Value *or* Single sample value	If ammonia testing is required only once per year and there is no column on your DMR, then record ammonia test data in the REMARKS section and write a comment indicating it is your annual test value. If there is a column provided and only one test is done per month, summarize value in the MAX, MXD, or SIN block at the bottom of your DMR. If you have a monthly or weekly testing requirement and there is no column, request a new preprinted form. Record in specific unit used in permit or form. Otherwise use mg/L.
BOD_5, lbs/day	Monthly Average, Max. Weekly Average	Calculate mass-based discharge level each time you do an effluent BOD_5 test. Average the *Daily Loading Values* to get the monthly average. Make sure flow reported on the DMR corresponds with the BOD_5 samples taken over the same time period. Use effluent flow values when they are available. Use formulas #3, 4, & 7.
TSS, lbs/day		See notes on BOD_5 loading above.
Metals	Monthly Avg & Daily Value *or* Single sample value	See comments for ammonia testing above. If you have questions about reporting metals data (or other toxins with very low detection levels), then refer to the section "Reporting Low Level Toxins Data," later in this manual. Contact your Ecology regional office or technical assistance officer for additional help.
Fecal Coliform Bacteria	Geometric Mean & Maximum Weekly Geometric Mean	See text and Appendix A for instructions on how to record a "Too Numerous To Count" (TNTC) value. Use formulas #8 & 9.

Footnotes

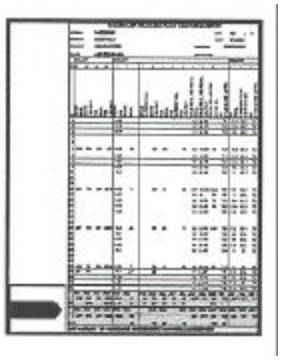
[a] *The following abbreviations are used in many preprinted DMR forms: AVG = Monthly Average, AVW = Maximum Weekly Average Concentration, GEM = Monthly Geometric Mean, GM7 = Maximum Weekly Geometric Mean, MXD or MAX = Maximum Daily Value, MIN = Minimum Daily Value, SIN = Single Sample*

[b] *Use Arithmetic Mean for calculating Average Values for all parameters except Fecal Coliform.*

[c] *See Formulas starting on page 8 and summarized in Appendix D.*

Table 3. General Instructions For Reporting Effluent Data on the DMR

Monthly Summary and Remarks Section



For most parameters, filling out the **Monthly Summary and Remarks Section** involves transferring maximum or minimum values or calculating an average value. All process control information (aeration basin, digester, lagoon, etc.) falls into this category. For influent and effluent reporting, there are differences in the methods for calculating the various averages. These methods are defined in regulation. If you use a different method than the ones shown below for calculating a reported value, you should call or write to Ecology to verify that it is correct. The calculations most frequently done incorrectly are the fecal coliform, monthly percent removal, and maximum weekly calculations. Each of these calculations is discussed below.

DMR Calculations

Most facilities use nine formulas when filling out the monthly DMR (Table 4). These formulas are illustrated in Tables 5 through 7.

FORMULA	PARAMETERS	UNITS
Daily Value	all parameters	all units possible
Monthly Average Concentration	BOD_5, TSS, DO, MLSS, MLVSS, Settleable Solids, Chlorine and other toxic chemicals	mg/L (ppm), µg/l (ppb)
Daily Loading	BOD_5, TSS, Chlorine, and other toxic chemicals	lbs/day
Monthly Average Loading	BOD_5, TSS	lbs/day
Monthly Percent Removal	BOD_5, TSS	percent
Maximum Weekly Concentration	BOD_5, TSS	mg/L
Maximum Weekly Average Loading	BOD_5, TSS	lbs/day
Monthly Geometric Mean	Fecal Coliform	colony forming units/100 ml (CFU)
Maximum Weekly Geometric Mean	Fecal Coliform	colony forming units/100 ml (CFU)

Table 4. Nine Most Frequently Used Formulas For Summarizing Monthly DMR Data

Formula #1: *Daily Values*--If you sample only once per day, then the test result for that sample is your *Daily Value*. However, if you sample more than once per day, you must average the results of the individual tests to get your daily value. You must also report the individual results and the time the samples were taken on the DMR or on a separate sheet of paper (only if multiple samples were taken that day). A 24-hr composite sample is considered a single sample. The most common calculation will be the *Daily Concentration Value*. Use this formula if extra chlorine tests are done on a single day.

Instructions: If you sample for a parameter more than once per day, then add the individual sample results and divide by the number of samples taken.

$$\textit{Daily Value} = \frac{\text{Sum of individual test results for each sample taken over one day}}{\text{Number of samples taken}}$$

Formula #2: *Monthly Average Concentration Values*–You will use this formula to calculate the monthly concentration values for BOD_5, TSS, Flow, settleable solids, and other parameters. The *Monthly Average Concentration* is an arithmetic mean–Tables 5 and 6 illustrate this calculation using data from Figure 1.

Instructions: Add the *Daily Concentration Values* together then divide by the number of days testing was done.

$$\textit{Monthly Average Concentration Value} = \frac{\text{Sum of } \textit{Daily Concentration Values}}{\text{Number of days testing was done during the month}}$$

Formula #3: *Daily Loading Value*–The *Daily Loading Value* is always expressed in lbs/day. Tables 5 and 6 show the *Daily Loading* calculations using Figure 1 data.

Instructions: Multiply the *Daily Concentration Value* by the Daily Average Flow value and the conversion factor 8.34.

Daily Loading Value (lbs/day) = *Daily Concentration Value* (mg/L) x Daily Average Flow (MGD) x 8.34 lbs/gal

Formula #4: *Monthly Average Loading*–The *Monthly Average Loading Value* is always expressed in lbs/day. Tables 5 and 6 show the *Monthly Average Loading* calculations using Figure 1 data.

Instructions: Add the *Daily Loading Values* for the calendar month together and divide by the number of days testing was done over the month.

$$\textit{Monthly Average Loading} \text{ (lbs/day)} = \frac{\text{Sum of } \textit{Daily Loading Values}}{\text{Number of days testing was done during the month}}$$

A. Influent BOD_5 Loading and Concentration Calculations

Time Period (week)	Daily Flow (MGD)	x	BOD_5 (mg/L)	x	8.34 (lbs/gal)	=	Daily Loading Value (lbs/day)
Day 6 (week 1)	0.33		200		8.34		550
Day 13 (week 2)	0.47		201		8.34		788
Day 20 (week 3)	0.60		195		8.34		976
Day 27 (week 4)	0.52		180		8.34		781
Day 28 (week 4)	0.40		205		8.34		684

Influent BOD_5 *Monthly Average Loading* (lbs/day) = $\frac{550 + 788 + 976 + 781 + 684}{5} = \frac{3779}{5} = 756$ lbs/day

Influent BOD_5 *Monthly Average Concentration* = $\frac{200 + 201 + 195 + 180 + 205}{5} = \frac{981}{5} = 196$ mg/L

B. Effluent BOD_5 Loading Calculations

Time Period (week)	Daily Flow (MGD)	x	BOD_5 (mg/L)	x	8.34 (lbs/gal)	=	Daily Loading Value (lbs/day)
Day 6 (week 1)	0.33		19		8.34		52
Day 13 (week 2)	0.47		6		8.34		24
Day 20 (week 3)	0.60		11		8.34		55 (highest)
Day 27 (week 4)	0.52		7		8.34		30 (weekly
Day 28 (week 4)	0.40		10		8.34		33 average = 32)

Effluent BOD_5 *Monthly Average Loading* (lbs/day) = $\frac{52 + 24 + 55 + 30 + 33}{5} = \frac{194}{5} = 39$ lbs/day

BOD_5 *Maximum Average Weekly* = 55 lbs/day

Effluent BOD_5 *Monthly Average Concentration* = $\frac{19 + 6 + 11 + 7 + 10}{5} = \frac{53}{5} = 11$ mg/L

C. Monthly Average Percent BOD_5 Removal Calculation

Monthly Average BOD_5 % Removal = $\frac{(196 - 11)}{196} \times 100 = 94\%$

Table 5. BOD_5 DMR Calculations - A. Influent loading and concentration calculations, B. Effluent loading calculations, C. Monthly Percent Removal. Sample values taken from Figure 1. Some Ecology regional offices do not require calculation A data for the DMR. (Modified from EPA NPDES Self-Monitoring System User Guide, 1985**)**

Formula #5: ***Monthly Average Percent Removal***–Express the results of this formula as a percentage (%). Unlike other calculations expressing monthly values, the *Monthly Percent Removal* is not an average of daily percent removals. Use only the **final** influent and effluent *Monthly Average Concentration* values to do this calculation. Although the results of each method will usually be very close, the one shown below is more forgiving (it is also defined in regulation that way!), especially when the daily percent removal values vary widely. Tables 5 and 6 show removal efficiency calculated using Figure 1 data.

Instructions: Subtract the *Monthly Average Effluent Concentration* from the *Monthly Average Influent Concentration*. Divide this by the *Monthly Average Influent Concentration*. Multiply this number by 100.

$$\textit{Monthly Average Percent (\%) Removal} = \frac{(\textit{Monthly Avg. Influent Conc.} - \textit{Monthly Avg. Effluent Conc.}) \times 100}{\textit{Monthly Average Influent Concentration}}$$

Formula #6: ***Maximum Weekly Average Concentration*****--**Because this formula is for BOD_5 and TSS only, the result will always be expressed in mg/L. This formula gives you the arithmetic mean of a week's testing for either BOD_5 or TSS. You will perform this calculation only on your effluent values. If your facility's permit requires that these parameters be tested only once per week, then that single value is your *Weekly Average Concentration*. If you do more than one test per week, then you must use all of those values in your weekly concentration calculation. Choose the greatest *Weekly Average Concentration Value* and report it as the *Maximum Weekly Average Concentration* for the month. Use the calculation below to get each weekly average.

Instructions: Add the *Daily Concentration Values* for the calendar week together and divide by the number of days tested that week.

$$\textit{Average Weekly Concentration} \text{ (mg/L)} = \frac{\text{Sum of one week's } \textit{Daily Concentration Values} \text{ for } BOD_5 \text{ or TSS}}{\text{Number of days } BOD_5 \text{ or TSS was tested that week}}$$

Formula #7: ***Maximum Weekly Average*** **Loading--**Unless your permit designates limits using the metric system, the result from this calculation will always be expressed in lbs/day. Like formula #6, it is used only for BOD_5 and TSS. You will perform this calculation only on your effluent values. If your facility's permit requires that these parameters be tested only once per week, then that single highest loading value for the month is your *Maximum Weekly Average Loading*. If you perform additional testing during a week, then you must use those additional values in your weekly (and monthly) concentration calculation(s).

Instructions: Add the *Daily Loading Values* for the calendar week together and divide by the number of days tested that week.

$$\textit{Maximum Average Weekly Loading} \text{ (lbs/day)} = \frac{\text{Sum of one week's } \textit{Daily Loading Values} \text{ for } BOD_5 \text{ or TSS}}{\text{Number of days } BOD_5 \text{ or TSS was tested that week}}$$

A. Influent TSS Loading and Concentration Calculations

Time Period (week)	Daily Flow (MGD)	x	TSS (mg/L)	x	8.34 (lbs/gal) =	Daily Loading Value (lbs/day)
Day 6 (week 1)	0.33		310		8.34	853
Day 13 (week 2)	0.47		300		8.34	1176
Day 20 (week 3)	0.60		305		8.34	1526
Day 27 (week 4)	0.52		290		8.34	1258

Influent TSS *Monthly Average Loading* (lbs/day) = $\frac{853 + 1176 + 1526 + 1258}{4} = \frac{4813}{4} = 1203$ lbs/day

Influent TSS *Monthly Average Concentration* = $\frac{310 + 300 + 305 + 290}{4} = \frac{1205}{4} = 301$ mg/L

B. Effluent Loading Calculations

Time Period (week)	Daily Flow (MGD)	x	TSS (mg/L)	x	8.34 (lbs/gal) =	Daily Loading Value (lbs/day)
Day 6 (week 1)	0.33		34		8.34	94 (highest)
Day 13 (week 2)	0.47		3		8.34	12
Day 20 (week 3)	0.60		15		8.34	75
Day 27 (week 4)	0.52		6		8.34	26

Effluent TSS *Monthly Average Loading* (lbs/day) = $\frac{94 + 12 + 75 + 26}{4} = \frac{207}{4} = 52$ lbs/day

TSS Maximum Average Weekly Loading = 94 lbs/day

Effluent TSS *Monthly Average Concentration* = $\frac{34 + 3 + 15 + 6}{4} = \frac{58}{4} = 15$ mg/L

C. Monthly Average Percent Removal Calculation

Monthly Average TSS % Removal = $\frac{(301 - 15)}{301} \times 100 = 95\%$

Table 6. Total Suspended Solids (TSS) DMR Calculations - A. Influent loading and concentration calculations, B. Effluent loading and concentration calculations, and C. Monthly Percent Removal calculation. Sample values taken from Figure 1.) (Modified from EPA NPDES Self-Monitoring System User Guide, 1985

Formula #8: ***Monthly Geometric Mean***–This formula is used only for reporting fecal coliform bacteria counts. Express the *Monthly Geometric Mean* in numbers of "organisms" or "colony forming units" per 100 ml–Table 7 illustrates this calculation using data from Figure 1.

Table 7 shows the fecal coliform calculations using Figure 1 data. As shown in part B of Table 7, you begin by converting the fecal coliform count for each day's test to a logarithm number. Next, you add all logarithm numbers together. Divide that sum by the number of counts. You finish by taking your last value and calculating its **anti-logarithm** (10^x). Figure 3 shows how this is done on the calculator that comes with Microsoft Windows software. If you are using a hand-held calculator, the buttons you use may be different. Check the calculator instructions. Sometimes the "INV" or *inverse* button is instead called the "2nd" button. Your regional Ecology technical assistance officer can assist you on how to use your specific calculator.

To obtain the anti-logarithm on the Microsoft calculator; 1) enter the log number (for example, 2.18 in Table 7, part B), 2) press the "INV" or "2nd" button, then 3) press the log button to get the geometric mean (which in this case should be 151).

Thus, the *Monthly Geometric Mean* calculation can be performed as follows:

Instructions: Add the logarithms of the *Daily Fecal Coliform Values* together then divide by the number of days testing was done. Compute the antilog of this number.

$$\textit{Monthly Geometric Mean} \text{ (\# org./100 ml)} = \text{antilog of} \left[\frac{\text{Sum of logarithms of } \textit{Daily Fecal Coliform Values} \text{ for the month}}{\text{Number of days tested}} \right]$$

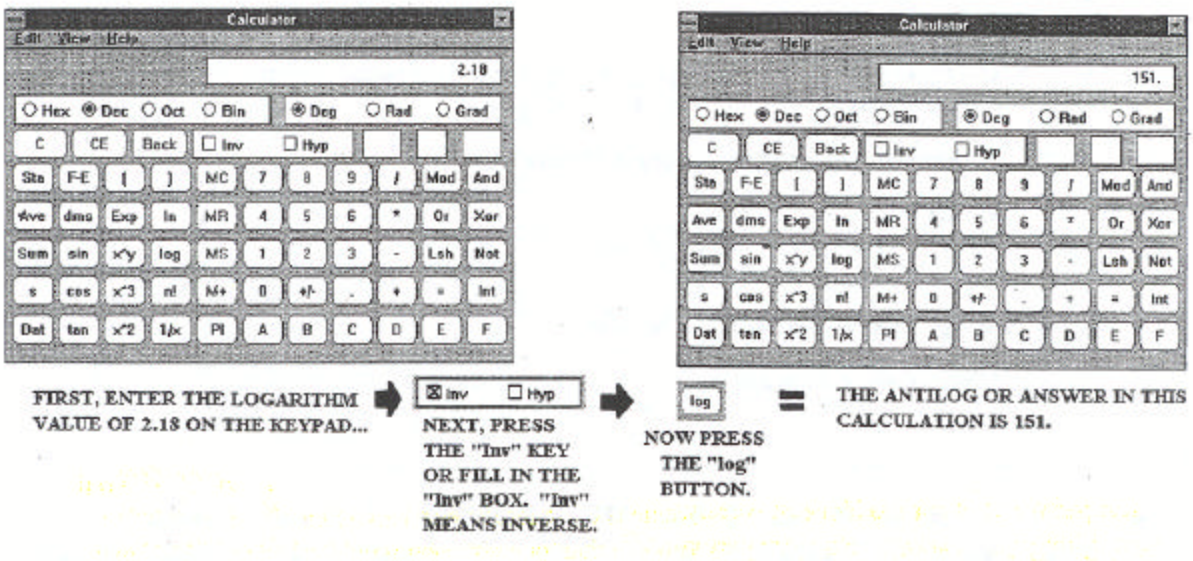


Figure 3. Using a calculator to compute the *Monthly Fecal Coliform Geometric Mean Value* (Formulas #8 and #9 in text)**.**

Part A. Data from Figure 1.

Time Period	Daily Fecal Coliform Values	Logarithm(s)
Week 1	75	1.875
Week 2	>10,000, 90, 75, 80	4, 1.954, 1.875, 1.903
Week 3	100	2
Week 4	45	1.653

Part B. Formula #8. *Monthly Geometric Mean* calculation:

$$\frac{1.875 + 4.0 + 1.954 + 1.875 + 1.903 + 2.0 + 1.653}{7} = \frac{15.26}{7} = 2.18$$

*********** *Monthly Geometric Mean* = Anti-log of 2.18 which = 151 ***********

Part C. Formula #9. *Maximum Weekly Geometric Mean* calculation (for week 2):

$$\frac{4.0 + 1.954 + 1.875 + 1.903}{4} = \frac{9.732}{4} = 2.433$$

*********Maximum Weekly Geometric Mean* = Anti-log of 2.433 = 271*******

*********** 271 is the highest weekly value so it is the *Maximum Weekly Geometric Mean* ***********

Table 7. Geometric Mean Calculations For Figure 1 Data - A. Data from Figure 1., B. Monthly Geometric Mean–formula #8, C. Maximum Weekly (7-day) Geometric Mean–formula #9

There is another method of calculating a *Geometric Mean* shown in Appendix B. Ecology prefers to promote the method shown above because it is the most popular one used and it closely resembles the other methods of averaging data.

It is possible to determine a number's logarithm using a logarithm chart instead of a calculator. Because of the accuracy and low cost of calculators today, Ecology **recommends** they be used instead of log charts. We will still accept data generated using log charts.

Formula #9: *Maximum Weekly Geometric Mean*--You perform this computation the same way as the *Monthly Geometric Mean* except that you summarize each week separately. If you perform only one test per week, record the single highest test value for the month asyour *Maximum Weekly Geometric Mean*. If you perform more than one test during a calendar week, you would calculate the geometric mean for that week as shown in Table 7, example C.

Instructions: Add the logarithms of the *Daily Fecal Coliform Values* together for each calendar week. Divide by the number of days testing was done that week. Compute the antilog of this number.

Maximum Weekly Geometric Mean = (# org./100 ml) or (colony forming units/100 ml)

$$\text{antilog of } \left[\frac{\text{Sum of logarithms of } \textit{Daily Fecal Coliform Values} \text{ for the week}}{\text{Number of days tested}} \right]$$

TNTC Values: How to Report Them and How Ecology Interprets Them

Upsets in the biological, physical, or chemical treatment processes of a plant can cause large shifts in the quality of effluent. Consequently, there could be large swings in the final level of fecal coliform bacteria. This is frequently reflected in the membrane filter (MF) test when the standard dilution/filtration series used results in plates that has colonies that are "too numerous to count" (TNTC). When scoring plates and determining the final fecal coliform test value, follow the Instructions for Determining Fecal Coliform Counts in Appendix A–these instructions supersede the analogous counting instructions in both Standard Methods (all editions), the EPA Microbiological Manual 1978, and the following Ecology guidance, Membrane Filter Procedure for the Fecal Coliform Test, A Manual for Sewage Treatment Plant Operators, revised January 1983. If you obtain TNTC counts on all the plates for a day's test, use the following procedure to determine the reporting value:

- Count the number of colonies on each plate to the best of your ability. If the number of fecal coliform colonies counted is greater than 200 on each of the plates, then assume the final count to be at least 200 organisms per plate. Calculate the *approximate* number of fecal coliform colonies using the count of 200 and the smallest filtration volume--note this as a TNTC value in the REMARKS section along with the reasons why you believe the TNTC count occurred and what measures are being taken to correct the problem. **You must use the estimated number in calculating your monthly and weekly limits for that reporting period. Use the "greater than" (>) symbol on the approximated number reported for that test in the Daily Reporting Section of the DMR (for example, >10,000 organisms/100 ml).** If the problem was due to lab error and resampling shows your fecal numbers to be well below the permit limit, your monthly and maximum weekly values will probably fall below or close to limit levels because of the forgiving nature of the geometric mean.

Whenever all plate counts are greater than 60 but under 200, the results should be reported as an *estimated* value and an "E" should precede the reported value for that test (for example, E120). This estimated value must be used in calculating the maximum weekly and monthly geometric means. An asterisk or other denotation is also allowable provided an appropriate explanation is provided in the REMARKS section or a separate sheet of paper.

Although it is possible that laboratory error could be to blame for a TNTC value, **Ecology assumes that a problem is occurring in your facility's treatment system unless you tell us otherwise.**

Ecology expects operators to evaluate the situation and follow the procedure below if no obvious problems are detected following a TNTC determination.

- Immediately resample and retest for fecal coliform bacteria. Continue to do daily tests for several days if necessary to help ensure that an intermittent problem has not developed in your disinfection system.

- Check the total residual chlorine levels to see if they are "normal."

If fecal coliform test results are all or nearly all zero, you should check to ensure that your incubator temperature is accurate and review your laboratory procedures. If they all check out OK, then you may be over chlorinating your effluent. Because chlorine is a toxic chemical, always try to minimize its use while ensuring that adequate disinfection is taking place.

If you are consistently reporting estimated values, you should either increase the sample volumes or change the dilution/filtration series used to obtain counts within the optimum range of 20-60.

Reporting Flow Data

Report flow data in the maximum (MAX) and average (AVG) rows of the Monthly Summary Section. Use either million gallons per day (MGD) or gallons per day (GPD), depending on which is specified on your preprinted DMR.

Example:

1,230,000 gal/day = 1.230 MGD
123,000 gal/day = 0.123 MGD
12,300 gal/day = 0.0123 MGD
1,230 gal/day = 0.00123 MGD

Reporting Monitoring Data Found Below Quantitation Levels

Some permits require very sensitive tests for metals or other chemicals with potentially toxic effects that could be present in your effluent. The limits for these toxic chemicals are sometimes below the level that standard laboratory equipment can accurately measure. In these cases, special reporting rules are necessary. Your facility's wastewater discharge permit is likely to have special language on how to report these low level values on the DMR so be sure to read sections S.1. and S.2. closely--follow any specific rules you find in your permit. The following is a brief explanation of the reporting rules and the reasoning behind the relatively complex reporting requirements.

The lowest level at which a toxic can be detected is called the "method detection level" or "MDL." As the name implies, this level varies with the testing method used. Although the chemical can be detected at this level, the amount is not measured accurately at this low level. For this reason, another level of accuracy called the "quantitation level" or "QL" was set for each

chemical. The QL = 5 x MDL. When reporting data on low level toxics on the DMR, follow the general rules below unless specified otherwise in the permit.

- When recording test data in the Daily Reporting Section:

  If a value is less than or equal to the MDL, report the value as ZERO. Use the value of ZERO for computing the *Monthly Average Concentration Value* (if such a limit exists for your facility).

  If the value is more than the MDL but less than the QL, record the actual value reported by your laboratory. Use the actual value to compute the *Monthly Average Concentration Value* (again, if such a limit exists for your facility).

- When reporting a *Maximum Daily Concentration Value* for a low-level toxic, report only those values that are equal to or greater than the QL. If there were no test values equal to or above the QL, report a value of ZERO for *the Maximum Daily Concentration Value*. The QL is fdifferent for each toxic being measured so keep a copy of the permit handy while summarizing data at the end of the month.

Read Special Conditions S.1. and S.2. carefully for a list of the MDLs to use and call your Ecology regional office if they are not present or you have additional questions on how to report data on toxics that occur at very low detection levels. If your laboratory is not capable of testing at these low levels then you should contact Ecology to discuss this problem.

Custom Forms from Your Computer System

Ecology frequently allows permittees to submit custom DMR forms generated by their own computer system. In general, custom forms must contain the same information required by the state DMR, the order of the parameters must be the same, and the certification statement must be present. Custom forms must be approved before they can be used. Contact your regional Ecology office if you are considering making your own form. You can also obtain a copy of your Ecology preprinted form in Microsoft® EXCEL software if desired.

REMARKS Area

Use the REMARKS section of the DMR for recording information regarding changes in operators, problems encountered in operation of the plant, repair of equipment, complaints, improvements, significant operational changes, etc. This is an excellent place to explain any violations that occurred during the month as well as your actions to remedy the problem. If there is insufficient room in the REMARKS Section, include your comments on a separate sheet of paper.

References

NPDES Self-Monitoring System, Users Guide, January 1985, Office of Water, Office of Water Enforcement and Permits, U.S. EPA, EN-338, 401 M Street S.W., Washington D.C. 20460.

Standard Methods for the Examination of Water and Wastewater. 18th edition, 1992. American Public Health Association, 1015 Fifteenth Street NW, Washington D.C., 20005

Wastewater Treatment Plant Operators Manual (Third Edition), November 1974. State of Washington Coordinating Council for Occupational Education, Olympia, WA.

Operation of Wastewater Treatment Plants, Volume *1*, Fourth Edition, California State University, Sacramento. Prepared for the U.S. EPA Office of Water Program Operations. Available from Ken Kerri, California State University, Sacramento, 6000 J Street, Sacramento, CA, 95819-6025, phone # 916-278-6142.

Membrane filter Procedure for the Fecal Coliform Test, A Manual for Sewage Treatment Plant Operators, Revised January 1983. by Janet Woodward, revised by Nancy Jensen, State of Washington Department of Ecology, Analytical Services Division, Olympia Environmental Laboratory, Olympia, Washington, 98503 (Environmental Investigation Laboratory, EILS)

Microbiological Methods for Monitoring the Environment, Water and Wastes, 1978, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, authors: Bordner, Robert H.; Winter, John A.; Scarpino, Pasquale, EPA Report Number 600-8-78-017

Users Guide, Membrane Filter Procedure for the Fecal Coliform Test. A Manual for Sewage Treatment Plant Operators. Unpublished manuscript. Quality Assurance Section, Environmental Investigations and Laboratory Services, Department of Ecology, P.O. Box 488, 2350 Colchester Dr., Manchester WA 98353-0488

Important Numbers and Other Information

Northwest Regional Office
Water Quality Program
Attention: Permit Coordinator
Mail Stop NB-81
3190 - 160th Ave. SE
Bellevue, WA 98008-5452
Phone: (425) 649-7000
FAX: (425) 649-7098

Eastern Regional Office
Water Quality Program
Attention: Permit Coordinator
N. 4601 Monroe
Suite 202
Spokane, WA 99205-1295
phone, 509-456-2926
FAX, 509-456-6175

Southwest Regional Office
Water Quality Program
Attention: Municipal/Industrial Permit Coordinator
P.O. Box 47775
Olympia, WA
98504-7775
phone, 360-407-6300
FAX, 360-407-6305

Central Regional Office
Water Quality Program
Attention: Permit Coordinator
15 West Yakima Ave, Suite 200
Yakima, WA 98902-3387
phone, 509-575-2491
FAX, 509-575-2809

Technical Assistance Officers:

Eastern and Central Washington: Otis Hampton, 509-575-2821
Northwestern and Southwestern Washington: Carl Jones, 360-407-6431

Appendix A: Determining Fecal Coliform Bacteria Counts

Sample Storage Requirements: Samples should be taken in *sterile* 125, 250, or 500 ml bottles or sterile specimen containers. Bottles used for chlorinated effluent are autoclaved for 15 minutes on liquid cycle with 0.2 ml of a 10 percent (or 2.0 ml of 1%) solution of sodium thiosulfate per 250 ml bottle (double this amount for 500 ml bottles). Samples can be stored for only six hours.

9.1 Microbiology values should be reported to two significant figures. Also, there is no such value as a log of zero. If a zero value is needed while performing a geometric mean calculation, use an approximate value of one count instead of zero counts. The value one has a log of zero.

9.2 Record densities as fecal coliform bacteria colonies per 100 ml. Special annotations may be necessary when individual plate counts are either below 20 or above 60 per plate. Use of either the terms CFU for "Colony Forming Units" or "organisms" per 100 ml is appropriate to express test units.

9.3 Basic calculation:

$$\frac{\text{number of colonies counted} \times 100}{\text{volume filtered (ml)}} = \text{Colony forming units (CFU) / 100 ml}$$

9.4 If only one sample plate has between 20-60 colonies, use that value for that one plate to calculate the test value:

4 colonies / 25 ml
10 colonies / 50 ml
25 colonies / 75 ml

$$\frac{25 \times 100}{75} = 33 \text{ CFU / 100 ml}$$

OR

50 colonies/ 25 ml
75 colonies/ 50 ml
195 colonies/100 ml

$$\frac{50 \times 100}{25} = 200 \text{ CFU / 100 ml}$$

9.5 If two or more plates have 20-60 colonies, figure each count separately and then average the results:

30 colonies / 10 ml,

$$\frac{30 \times 100}{10} = 300 \text{ CFU / 100 ml}$$

58 colonies / 25 ml,

$$\frac{58 \times 100}{25} = 232 \text{ CFU / 100 ml}$$

Average =

$$\frac{300 + 232}{2} = 266 \text{ CFU / 100 ml}$$

9.6 If no plates are within the 20-60 range and two or more plates have counts adding up to 20-60 colonies, add those plates together and throw out the high value:

6 colonies /10 ml
18 colonies / 25 ml $\quad \frac{(6+18) \times 100}{(10+25)} = 69$ CFU / 100 ml
80 colonies / 50 ml

9.7 If counts are below 20 and do not add up to between 20 and 60, add them to get a higher volume and report the value as being *estimated*. You should use 0 count values in the calculation:

0 colonies / 2 ml
5 colonies / 10 ml $\quad \frac{(0+5+9) \times 100}{(2+10+25)} = \frac{(14) \times 100}{37} =$ E38 CFU/ 100ml
9 colonies / 25 ml

9.8 If all counts are over 60 but less than 200, take the plate with the smallest filtration volume and report the value as being *estimated*:

90 colonies /10 ml
110 colonies / 25 ml $\quad \frac{90 \times 100}{10} =$ E900 CFU
170 colonies / 35 ml

9.9 If all counts are over 200 (counts greater than 200 are considered "Too Numerous To Count" or "TNTC") use the value 200 and the smallest filtration volume to approximate the fecal coliform numbers and report the value as being *greater than*. Use this value in the Daily Reporting Section of the DMR. Report TNTC in the REMARKS Section of the DMR or on a separate piece of paper along with your explanation of why you believe a TNTC value was obtained and what measures are being taken to correct the problem. (Resample and retest until good fecal counts are achieved and within permit limits; report all tests taken).

>200 colonies /10 ml
>200 colonies / 25 ml $\quad \frac{200 \times 100}{10} =$ > 2,000 CFU / 100 ml
>200 colonies / 35 ml

Other Information:

Dealing with high turbidity: Effluents with high TSS, algal and mold growth, and high pH can be difficult to filter in a reasonable time (if a sample will not filter in a minute or two, it is too large). This is a common problem with lagoon effluents. A large amount of sediment on a membrane can interfere with proper growth of fecal coliforms. Slime, mold, and other nuisance colonies may overgrow membranes and make them impossible to count. This can be the reason for the largest volume filtered having lower counts than smaller volumes. The easiest way to deal with this is to filter multiple smaller volumes. For example, if 50 ml is needed, but will not go through the filter, try five 10-ml volume filtrations (on five different filters) or one 20 and three 10 ml portions.

Membrane filters: Membrane filters have been developed that can often produce better recovery of fecal coliform bacteria from chlorinated effluents. They have a larger pore size and may reduce filtration times. The standard 0.45 µM pore size membranes are acceptable, but these specialized membranes retain organisms within the filter rather than on the surface, and thus help to prevent evaporation and heat damage to chlorine-injured fecal coliforms during the critical first few hours at the high temperature of the test. These filters are now widely available.

Choosing sample volumes: Fecal coliform bacteria counts are usually fairly uniform and there is generally no problem choosing the best volumes to filter; however, unreliable chlorination or fluctuating effluent quality can produce a wide range of fecal coliform levels. Picking the best volumes can reduce the number of tests and assure getting the best results.

- A volume difference of three-fold (four-fold at the most) is best for getting countable plates. For example, 1, 3, and 10 ml; 2, 6 (or 5), and 20 ml; 10, 30, and 100 ml.

- Sample volumes that are too close together are wasteful; 5, 10, 20, and 50 ml are too close together. Using 5, 20, and 50 would provide the same spread.

- Make sure that the small volumes are really needed. If the smallest volume is always negative or always has just a few colonies, it is not necessary. It may be better to do an additional large volume.

Note regarding the use of zero values in fecal coliform calculations: Because the logarithm of zero is an "undefined" number, you must use a value of zero (or other very small number) for the logarithm of zero when performing geometric mean calculations. If you are designing a computer spreadsheet to perform your calculations, one suggestion is to automatically enter a value of 0.1 for the actual count instead of zero. Then assign the log of anything less than one to be equal to 10^{-10}.

Appendix B: Additional Notes on Fecal Coliform Calculations

An alternative method for calculating the *Monthly Geometric Mean* is shown below. It does not require the use of logarithms. As shown in Table B1, part B, all the daily fecal coliform values are first multiplied together (in this case the number will be 1.822×10^{15}). In the example problem, there are seven numbers. Because there are seven numbers, you then take the seventh root of the multiplied numbers (if there were five numbers you would take the fifth root). Figure B1 shows how to perform the calculation on the calculator that comes with the Microsoft Windows software.

Thus, the Alternative *Monthly Geometric Mean* calculation is performed as follows:

Instructions : Multiply all the daily fecal coliform values together. Take the nth root of this number where n = number of days tested that month.

Monthly Geometric Mean (# org./100 ml) = nth root of...[Product of all daily fecal coliform numbers for that month]

Part A. Data from Figure 1.

Time Period	Daily Fecal Coliform Values	Logarithm(s)
Week one	75	1.875
Week two	>10,000, 90, 75, 80	4, 1.954, 1.875, 1.903
Week three	100	2
Week four	45	1.653

Part B. Alternative *Monthly Geometric Mean* calculation, method #1:

$75 \times 10{,}000 \times 90 \times 75 \times 80 \times 100 \times 45 = 1{,}822{,}500{,}000{,}000{,}000 = 1.8225 \times 10^{15}$

*********** *Monthly Geometric Mean* = the 7th root of 1,822,500,000,000,000 which = 158 ***********

Part C. Alternative *Maximum Weekly Geometric Mean* calculation, method #1 (for week 2):

$10{,}000 \times 90 \times 75 \times 80 = 5{,}400{,}000{,}000 = 5.4 \times 10^{9}$

the 4th root of 5,400,000,000 = 271

*********** 271 is the highest weekly value so it is the *Maximum Weekly Geometric Mean* ***********

Table B1. Geometric Mean Calculations for Figure 1 Data - A. Data from Figure 1., B. Alternative Monthly Geometric Mean calculation, method #1: C. Alternative Maximum Weekly (7-day) Geometric Mean calculation, method #1.

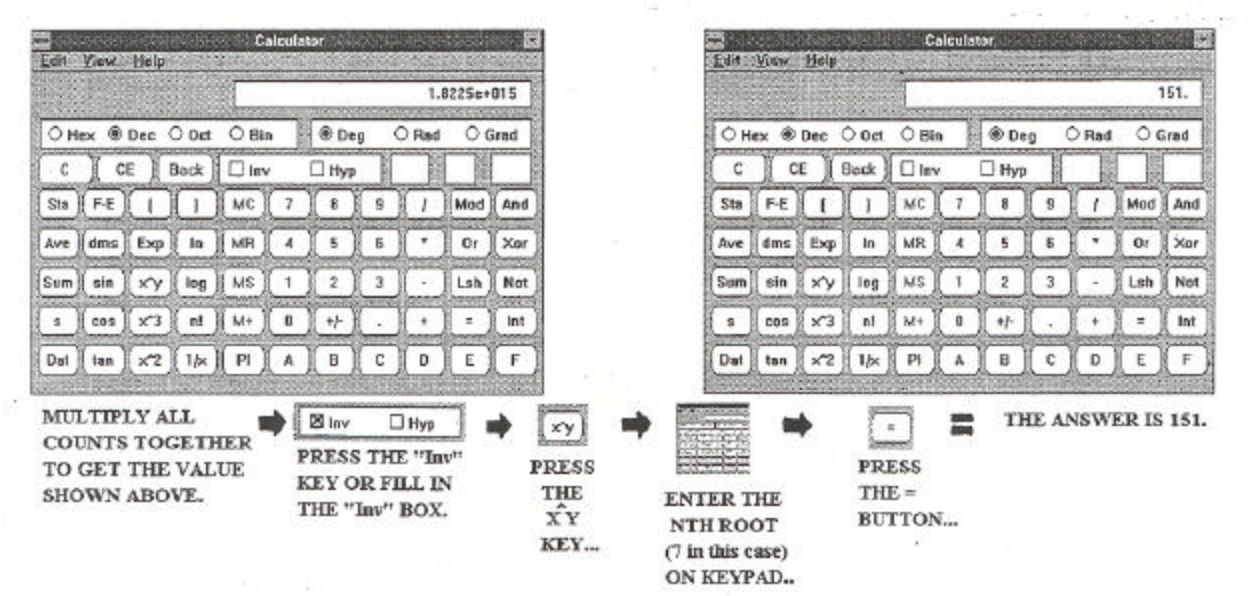


Figure B1. Using A Calculator To Perform The Alternative *Monthly* And *Maximum Weekly Fecal Coliform Geometric Mean* Calculations.

Perform the Alternative *Maximum Weekly Geometric Mean* calculation in the same way as the *Monthly Geometric Mean* except that each week is summarized separately. If you perform only one test per week, the single highest weekly value is considered your *Maximum Weekly Geometric Mean*. If for one or more weeks you perform more than one test, you would calculate the geometric mean for that week as shown in Table B1, example C.

Instructions : Multiply all daily fecal coliform values together for a calendar week. Take the nth root of this number where n = number of days tested that week.

Monthly Geometric Mean (org./100 ml) = nth root of...[Product of all daily fecal coliform values from one week's tests]

Appendix C: Glossary

Some of the terms below are not found in the DMR Instruction Manual but may be used in your facility's NPDES permit.

Acute Toxicity–The lethal effect of a compound on an organism that occurs in a short period of time, usually 48 to 96 hours.

Ambient Water Quality–The existing environmental condition of the water in a receiving water body.

Ammonia–Ammonia is produced by the breakdown of nitrogenous materials in wastewater. Ammonia is toxic to aquatic organisms, exerts an oxygen demand, and contributes to eutrophication. It also increases the amount of chlorine needed to disinfect wastewater.

Anti-logarithm–The number for which a given logarithm stands. For example, in the equation "log 100 = 2," the log of 100 is 2 and the antilogarithm of 2 is 100.

Average Monthly Value–The average of the measured values obtained over a calendar month's time.

Best Management Practices (BMPs)–Schedules of activities, prohibitions of practices, maintenance procedures, and other physical, structural and/or managerial practices to prevent or reduce the pollution of waters of the state. BMPs include treatment systems, operating procedures, and practices to control: plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage. BMPs may be further categorized as operational, source control, erosion and sediment control, and treatment BMPs.

BOD_5–Determining the Biochemical Oxygen Demand of an effluent is an indirect way of measuring the quantity of organic material present in an effluent that is utilized by bacteria. The BOD_5 is used in modeling to measure the reduction of dissolved oxygen in a receiving water after effluent is discharged. Stress caused by reduced dissolved oxygen levels makes organisms less competitive and less able to sustain their species in the aquatic environment. Although BOD is not a specific compound, it is defined as a conventional pollutant under the federal Clean Water Act.

Bypass–The intentional diversion of waste streams from any portion of a treatment facility.

Calendar Month–The time spanning from the first day of the month to the last.

Calendar Week–The time spanning from Sunday through Saturday. Use these time periods to determine weekly averages. See the section "How to Define Time Periods" when two months fall into one week.

Chlorine–Chlorine is used to disinfect wastewater of pathogens harmful to human health. It is also extremely toxic to aquatic life.

Chronic Toxicity–The effect of a compound on an organism over a relatively long time, often 1/10 of an organism's lifespan or more. Chronic toxicity can measure survival, reproduction or growth rates, or other parameters to measure the toxic effects of a compound or combination of compounds.

Compliance Inspection without Sampling–A walk-through inspection of a facility to determine status with regard to permit limits and conditions. The inspection includes a review of procedures for obtaining data from the lab and transferring data to Ecology in DMRs. The status of submittals required by the wastewater discharge permit is examined. This type of inspection is equivalent to an EPA Class 1 inspection.

Compliance Inspection with Sampling–An inspection of a facility that includes the elements of a Compliance Inspection (see previous definition) plus sampling and testing of wastewater and influent to the treatment system. It may also include a review of the facility's record of environmental compliance. This type of inspection is equivalent to an EPA Class 2 inspection.

Clean Water Act (CWA)–The Federal Water Pollution Control Act enacted by Public Law 92-500, as amended by Public Laws 95-217, 95-576, 96-483, 97-117; USC 1251 et seq.

Combined Sewer Overflow (CSO)–The event during which excess combined sewage flow caused by inflow is discharged from a combined sewer, rather than conveyed to the sewage treatment plant because either the capacity of the treatment plant or the combined sewer is exceeded.

Composite Sample–A mixture of grab samples collected at the same sampling point at different times, formed either by continuous sampling or by mixing discrete samples. May be "time-composite" (collected at constant time intervals) or "flow-proportional" (collected either as a constant sample volume at time intervals proportional to stream flow, or collected by increasing the volume of each aliquot as the flow increased while maintaining a constant time interval between the aliquots).

Construction Activity–Clearing, grading, excavation, and any other activity which disturbs the surface of the land. Such activities may include road building; construction of residential houses, office buildings, or industrial buildings; and demolition activity.

Critical Condition–The time during which the combination of receiving water and waste discharge conditions have the highest potential for causing toxicity in the receiving water environment. This situation usually occurs when the flow within a water body is low, thus, its ability to dilute effluent is reduced.

Dilution Factor–A measure of the amount of mixing of effluent and receiving water that occurs at the boundary of the mixing zone. Expressed as the inverse of the effluent fraction.

Engineering Report–A document which thoroughly examines the engineering and administrative aspects of a particular domestic or industrial wastewater facility. The report shall contain the appropriate information required in WAC 173-240-060 or 173-240-130.

Fecal Coliform Bacteria–Fecal coliform bacteria are used as indicators of pathogenic bacteria in the effluent that are harmful to humans. Pathogenic bacteria in wastewater discharges are controlled by disinfecting the wastewater. The presence of high numbers of fecal coliform bacteria in a water body can indicate the recent release of untreated wastewater and/or the presence of animal feces.

Grab Sample–A single sample or measurement taken at a specific time or over as short period of time as is feasible.

Holding Time–The time between the end of an individual sampling event and the beginning of the testing event. For composite samples, holding time begins at the end of the 24 hours of sampling. In general, proper holding times can me found in Standard Methods for the Examination of Water and Wastewater.

Industrial Wastewater–Water or liquid-carried waste from industrial or commercial processes, as distinct from domestic wastewater. These wastes may result from any process or activity of industry, manufacture, trade or business, from the development of any natural resource, or from animal operations such as feed lots, poultry houses, or dairies. The term includes contaminated stormwater and, also, leachate from solid waste facilities.

Infiltration and Inflow (I/I)–"Infiltration" means the addition of ground water into a sewer through joints, the sewer pipe material, cracks, and other defects. "Inflow" means the addition of rainfall-caused surface water drainage from roof drains, yard drains, basement drains, street catch basins, etc., into a sewer.

Interim Limit–A temporary limit established in either a wastewater permit or in an Administrative Order. This type of limit is usually set while a plant undergoes upgrading to improve treatment or while it gathers data to see if a new limit is needed to meet state standards.

Final Limit–A limit established in your facility's permit that is based on the design capacity of the plant and other state standards. Most permit limits are final limits and are found in permit condition S1. Final limits last for the duration of your facility's permit and are reevaluated at the time of permit renewal.

Logarithm–The exponent indicating the power to which a fixed number, the base, must be raised to produce a given number. For example, for the equation 10^2,= 100, the logarithm of 100 is 2.

Maximum Daily Value–The greatest allowable value for any calendar day.

MDL–Method Detection Level. This is the smallest concentration at which a compound can be detected for a given analytical method.

Mixing Zone–An area that surrounds an effluent discharge within which water quality criteria may be exceeded. The area of the authorized mixing zone is specified in a facility's permit and follows procedures outlined in state regulations (chapter 173-201A WAC).

National Pollutant Discharge Elimination System (NPDES)–The NPDES (Section 402 of the Clean Water Act) is the federal wastewater permitting system for discharges to navigable waters of the United States. Many states, including the state of Washington, have been delegated the authority to issue these permits. NPDES permits issued by Washington State permit writers are joint NPDES/state permits issued under both state and federal laws.

O&M Manual–Operations and Maintenance Manual. This is a manual that explains the basic operating principles and limits for a sewage treatment facility. It generally provides the minimum level of testing and maintenance needed at a plant. Permittees are expected to follow the O&M Manual in the operation of the plant.

Parameter–A test or calculation that is based on test data or personal observation.

pH–The pH of a liquid measures its acidity or alkalinity. A pH of 7 is defined as neutral, and large variations above or below this value are considered harmful to most aquatic life.

POTW–Publicly owned treatment works.

ppb–Parts per billion (1 µg/Liter)

ppm–Parts per million (1mg/Liter)

QL–Quantitation limit. A numerical limit that is five times greater than the MDL (Method Detection Limit).

Responsible Official–A principal executive officer of a city or town or the ranking elected official.

Representative Sampling–Sampling that reflects the general quality of effluent discharged. It is assumed that the testing schedule established in a permit will reflect the quality of effluent discharged as long as the plant is running normally and is not upset by unusual events.

Slug Load–An atypical discharge to the plant that occurs intermittently. An illegal discharge of fuel oil or high strength waste to the collection system, which might upset the plant, would constitute a slug load.

State Waters–Lakes, rivers, ponds, streams, inland waters, underground waters, salt waters, and all other surface waters and watercourses within the jurisdiction of the state of Washington.

Stormwater–That portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, pipes, and other features of a stormwater drainage system into a defined surface water body, or a constructed infiltration facility.

Technology-based Effluent Limit–A permit limit that is based on the ability of a treatment method to reduce the pollutant.

TNTC–Too Numerous to Count. When the number of colonies detected on a fecal coliform test plate exceeds 200, it is considered to be TNTC.

Total Suspended Solids (TSS)–The particulate material in an effluent. Large quantities of TSS discharged to a receiving water may result in solids accumulation. Apart from any toxic effects attributable to substances leached out by water, suspended solids may kill fish, shellfish, and other aquatic organisms by causing abrasive injuries and by clogging the gills and respiratory passages of various aquatic fauna. Indirectly, suspended solids can screen out light and can promote and maintain the development of noxious conditions through oxygen depletion.

Upset–An exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, lack of preventative maintenance, or careless or improper operation.

Water Quality-based Effluent Limit–A limit on the concentration of an effluent parameter that is intended to prevent the concentration of that parameter from exceeding its water quality criterion after it is discharged into a receiving water.

Appendix D:
DMR Calculations Summary Sheet

Formula #1:

Daily Concentration Value = $\frac{\text{Sum of individual test results for each sample taken over one day}}{\text{Number of samples taken}}$

Formula #2:

Monthly Average Concentration = $\frac{\text{Sum of } \textit{Daily Concentration} \text{ values}}{\text{Sum of days tested}}$

Formula #3:

Daily Loading Value (lbs/day) = *Daily Concentration Value* (mg/L) x Average Daily Flow (MGD) x 8.34 lbs/gallons

Formula #4:

Monthly Average Loading (lbs/day) = $\frac{\text{Sum of Daily Loading Values}}{\text{Number of days testing was done during the month}}$

Formula #5:

Monthly Average Percent Removal (percentage) = $\frac{(\textit{Avg. Monthly Influent Conc.} \text{ (mg/L)} - \textit{Avg. Monthly Effluent Conc.} \text{ (mg/L)}) \times 100}{\textit{Monthly Average Influent Concentration} \text{ (mg/L)}}$

Formula #6:

Maximum Average Weekly Concentration (mg/L) = $\frac{\text{Sum of one week's } \textit{Daily Concentration Values} \text{ for } BOD_5 \text{ or TSS}}{\text{Number of days } BOD_5 \text{ or TSS was tested that week}}$

Formula #7:

Maximum Weekly Loading (lbs/day) = $\frac{\text{Sum of one week's } \textit{Daily Loading Values} \text{ for } BOD_5 \text{ or TSS}}{\text{Number of days } BOD_5 \text{ or TSS was tested that week}}$

Formula #8:

Monthly Geometric Mean (# org./100 ml = antilog of $\left[\frac{\text{Sum of logarithms of } \textit{Daily Fecal Coliform Values} \text{ for the month}}{\text{Number of days tested}}\right]$

Formula #9:

Maximum Weekly Geometric Mean (# org./100 ml) = antilog of $\left[\frac{\text{Sum of logarithms of } \textit{Daily Fecal Coliform Values} \text{ for the week}}{\text{Number of days tested}}\right]$

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